(19)日本国特許庁（ＪＰ）　(12)公開特許公報（Ａ）　(11)特許出願公開番号
特開2000－162318
（P2000－162318A）
(43)公開日　平成12年６月16日(2000.6.16)

(51)Int.Cl.[7]	識別記号	ＦＩ		テーマコード（参考）
Ｇ０１Ｓ　17/08		Ｇ０１Ｓ　17/08		２Ｆ０６５
Ｇ０１Ｂ　11/00		Ｇ０１Ｂ　11/00	Ｂ	２Ｆ０６９
21/22		21/22		２Ｆ１１２
Ｇ０１Ｃ　3/06		Ｇ０１Ｃ　3/06	Ｚ	５Ｊ０８４
Ｇ０１Ｓ　7/48		Ｇ０１Ｓ　7/48	Ａ	

審査請求　未請求　請求項の数３　ＯＬ　（全９頁）

(21)出願番号　特願平10－333072

(22)出願日　平成10年11月24日(1998.11.24)

(71)出願人　000236436
浜松ホトニクス株式会社
静岡県浜松市市野町1126番地の１

(72)発明者　仲瀬　重樹
静岡県浜松市市野町1126番地の１　浜松ホトニクス株式会社内

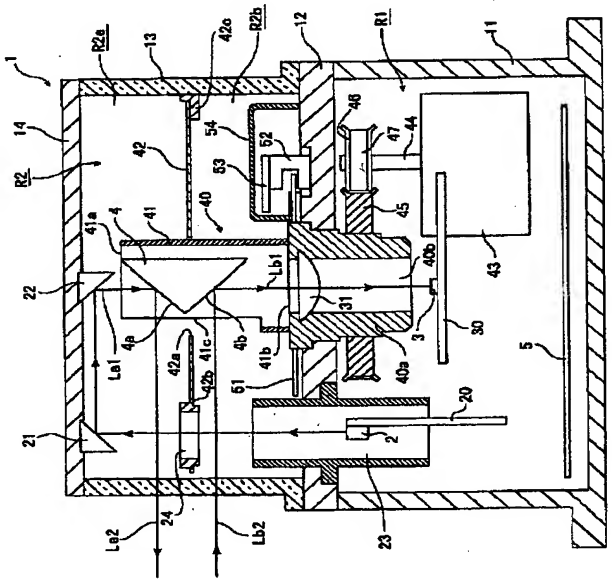
(72)発明者　川合　孝明
静岡県浜松市市野町1126番地の１　浜松ホトニクス株式会社内

(74)代理人　100088155
弁理士　長谷川　芳樹　（外２名）

最終頁に続く

(54)【発明の名称】　全方位距離検出装置

(57)【要約】
【課題】　３６０度にわたって高精度での距離検出が可能な全方位距離検出装置を提供する。
【解決手段】　投光領域Ｒ２ａ及び受光領域Ｒ２ｂからなる光学系領域Ｒ２の一方側に、投光器２、受光器３及び信号処理回路５がともに設置される領域である駆動系領域Ｒ１を設けた構成とすることによって、それら相互間の信号線等の配線が光学系領域Ｒ２内を通過しないようにして完全な３６０度の全方位距離検出が可能な全方位距離検出装置とすることができる。また、これによって配線の距離が短縮されるので、回転機構の駆動系等に起因する受光信号等への電気的ノイズの影響が抑制され、距離検出の精度を向上させることができる。



1

【特許請求の範囲】

【請求項１】　ハウジング内部に投光器と受光器とを備え、

前記投光器からの照射光を投光光路変換手段を介して前記ハウジング外部の所定の検出方向に出射し、前記検出方向の物体からの反射光を受光光路変換手段を介して前記受光器に入射して、前記物体の有無及び前記物体までの距離を検出する距離検出装置において、

前記ハウジング内部の所定の軸を回転軸として回転可能に設置された回転部と、前記回転部を駆動させる回転駆動部とを有して構成され、前記投光光路変換手段及び前記受光光路変換手段が前記回転軸上に固定・設置される回転機構と、

前記回転部の回転角度を検出する角度検出手段と、

前記投光器及び前記受光器からの信号による前記物体までの距離の検出と、前記角度検出手段からの信号による前記物体のある角度の検出と、を行う信号処理回路と、を備えるとともに、

前記ハウジング内部の領域は、前記回転軸の方向に沿って、光学系領域と、前記投光器、前記受光器及び前記信号処理回路が内部に配置されている駆動系領域と、に分割されるとともに、前記光学系領域の側壁は、光を透過する透明円筒で構成され、

前記光学系領域は、前記回転軸の方向に沿って、前記投光光路変換手段を内部に含んで前記照射光が前記検出方向へと出射される投光領域と、前記駆動系領域に隣接し、前記受光光路変換手段を内部に含んで前記反射光が前記検出方向から入射される受光領域と、にさらに分割されるとともに、前記投光領域と前記受光領域とは、前記透明円筒に対して固定されて設置され光路からはずれた迷光を遮光する遮光手段によって光学的に分割され、

前記受光器は、前記回転軸上に前記受光光路変換手段に対向して配置され、

前記投光領域内部に設置されて、前記投光器からの前記照射光を前記投光光路変換手段に導光する照射光導光手段を有することを特徴とする全方位距離検出装置。

【請求項２】　ハウジング内部に投光器と受光器とを備え、

前記投光器からの照射光を投光光路変換手段を介して前記ハウジング外部の所定の検出方向に出射し、前記検出方向の物体からの反射光を受光光路変換手段を介して前記受光器に入射して、前記物体の有無及び前記物体までの距離を検出する距離検出装置において、

前記ハウジング内部の所定の軸を回転軸として回転可能に設置された回転部と、前記回転部を駆動させる回転駆動部とを有して構成され、前記投光光路変換手段及び前記受光光路変換手段が前記回転軸上に固定・設置される回転機構と、

前記回転部の回転角度を検出する角度検出手段と、

前記投光器及び前記受光器からの信号による前記物体までの距離の検出と、前記角度検出手段からの信号による前記物体のある角度の検出と、を行う信号処理回路と、を備えるとともに、

前記ハウジング内部の領域は、前記回転軸の方向に沿って、光学系領域と、前記投光器、前記受光器及び前記信号処理回路が内部に配置されている駆動系領域と、に分割されるとともに、前記光学系領域の側壁は、光を透過する透明円筒で構成され、

前記光学系領域は、前記回転軸の方向に沿って、前記駆動系領域に隣接し、前記投光光路変換手段を内部に含んで前記照射光が前記検出方向へと出射される投光領域と、前記受光光路変換手段を内部に含んで前記反射光が前記検出方向から入射される受光領域と、にさらに分割されるとともに、前記投光領域と前記受光領域とは、前記透明円筒に対して固定されて設置され光路からはずれた迷光を遮光する遮光手段によって光学的に分割され、

前記投光器は、前記回転軸上に前記投光光路変換手段に対向して配置され、

前記受光領域内部に設置されて、前記受光光路変換手段からの前記反射光を前記受光器に導光する反射光導光手段を有することを特徴とする全方位距離検出装置。

【請求項３】　前記角度検出手段は、

前記回転部の外周に固定され、前記回転軸を中心とする所定の円上に等間隔に設けられた複数のスリットからなる角度検出スリット群を有する角度検出円盤と、

前記スリットの通過を光電的に検出する光電ユニットと、

所定の周波数を有する高速パルス状の電気信号を発生するクロック回路と、

前記光電ユニットによる前記スリットの検出と、前記クロック回路による前記電気信号のパルス数とを用いて物体のある角度を演算する角度演算手段と、を備えることを特徴とする請求項１または２記載の全方位距離検出装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、周囲３６０度にわたって物体の有無、物体までの距離及び物体のある角度を検出可能な全方位距離検出装置に関するものである。

【０００２】

【従来の技術】従来、例えば無人搬送車に搭載する距離センサシステムとして、外部に出射される照射光を発生させるレーザや発光ダイオードなどを用いた投光器と、物体からの反射光を検出するフォトダイオードなどを用いた受光器とを有して構成されて、受光の有無によって検出方向における物体の有無を、また、投光と受光との時間差などから物体までの距離を検出する距離検出装置が知られている。

【０００３】このような装置における検出方向は、外部への照射光の投光及び外部からの反射光の受光が行われ

る方向である。この検出方向は、例えば投光器から出射される照射光、及び受光器へ入射される反射光の光路を光路変換手段である反射ミラーなどの反射手段によって所定の方向に変換することによって、選択することができる。ここで、光路変換手段を所定の回転軸によって回転可能な回転機構に固定・設置される構成として検出方向の連続的な変更を可能にし、光路変換手段が回転される周囲の側壁を外部に向けて光学的に開放された構成とすることによって、検出方向を周囲ほぼ３６０度にわたって回転・変更させることが可能である。これによって、全方位について物体までの距離の検出を行うことができる全方位型の距離検出装置とすることができる。

【０００４】上記したような全方位距離検出装置においては、投光・受光による物体までの距離の検出に加えて、物体のある角度（方向）を検出することによって、検出された物体の位置を特定することができる。すなわち、物体からの反射光の受光の有無によって物体の有無を検出するとともに、反射光が受光され物体が存在する場合には、投光・受光の時間差などによって物体までの距離を、また、検出方向の回転角度を測定可能なように回転機構に対して設置された透過型光学式エンコーダなどの角度検出手段によって物体のある角度を検出する。このような装置としては、例えば特開平７－１９１１４２号及び特開平１０－１０２３３号に開示された装置がある。

【０００５】

【発明が解決しようとする課題】上記した従来の全方位距離検出装置においては、回転軸上に固定されている光路変換手段に対して投光器及び受光器はその回転軸上に対向して、光路変換手段の所定の反射面にそれぞれ面するように配置されている。すなわち、回転軸の一方の端部には投光器が配置されて、回転軸に沿って照射光が出射され投光ミラーなどの光路変換手段によって回転軸に対して垂直な方向である検出方向に光路が変換されて、外部に出射される。一方、回転軸の他方の端部には受光器が配置されて、検出方向から入射される物体からの反射光が受光ミラーなどの光路変換手段によって回転軸に沿った方向に光路が変換されて、受光器に入射される。

【０００６】このような構成による装置においては、投光器及び受光器が回転軸のほぼ両端、したがって装置の両端に設置されるために信号線等の配線が長くなり、この配線によって回転機構等の設計上の自由度が制限されてしまうという問題があった。また、外部への照射光の投光及び外部からの反射光の受光が行われる領域内をこの配線が通過する必要があるため、完全な３６０度の全方位距離検出が不可能であった。さらに、このような長い配線は、回転機構の回転駆動系等からの電気的ノイズの影響を増大させて、距離検出の精度を劣化させる原因ともなる。

【０００７】本発明は、上記の問題点に鑑みてなされたものであり、３６０度にわたって高精度での距離検出が可能な全方位距離検出装置を提供することを目的とする。

【０００８】

【課題を解決するための手段】このような目的を達成するために、本発明による全方位距離検出装置は、ハウジング内部に投光器と受光器とを備え、投光器からの照射光を投光光路変換手段を介してハウジング外部の所定の検出方向に出射し、検出方向の物体からの反射光を受光光路変換手段を介して受光器に入射して、物体の有無及び物体までの距離を検出する距離検出装置において、ハウジング内部の所定の軸を回転軸として回転可能に設置された回転部と、回転部を駆動させる回転駆動部とを有して構成され、投光光路変換手段及び受光光路変換手段が回転軸上に固定・設置される回転機構と、回転部の回転角度を検出する角度検出手段と、投光器及び受光器からの信号による物体までの距離の検出と、角度検出手段からの信号による物体のある角度の検出と、を行う信号処理回路と、を備えるとともに、ハウジング内部の領域は、回転軸の方向に沿って、光学系領域と、投光器、受光器及び信号処理回路が内部に配置されている駆動系領域と、に分割されるとともに、光学系領域の側壁は、光を透過する透明円筒で構成され、光学系領域は、回転軸の方向に沿って、投光光路変換手段を内部に含んで照射光が検出方向へと出射される投光領域と、駆動系領域に隣接し、受光光路変換手段を内部に含んで反射光が検出方向から入射される受光領域と、にさらに分割されるとともに、投光領域と受光領域とは、透明円筒に対して固定されて設置され光路からはずれた迷光を遮光する遮光手段によって光学的に分割され、受光器は、回転軸上に受光光路変換手段に対向して配置され、投光領域内部に設置されて、投光器からの照射光を投光光路変換手段に導光する照射光導光手段を有することを特徴とする。

【０００９】また、ハウジング内部に投光器と受光器とを備え、投光器からの照射光を投光光路変換手段を介してハウジング外部の所定の検出方向に出射し、検出方向の物体からの反射光を受光光路変換手段を介して受光器に入射して、物体の有無及び物体までの距離を検出する距離検出装置において、ハウジング内部の所定の軸を回転軸として回転可能に設置された回転部と、回転部を駆動させる回転駆動部とを有して構成され、投光光路変換手段及び受光光路変換手段が回転軸上に固定・設置される回転機構と、回転部の回転角度を検出する角度検出手段と、投光器及び受光器からの信号による物体までの距離の検出と、角度検出手段からの信号による物体のある角度の検出と、を行う信号処理回路と、を備えるとともに、ハウジング内部の領域は、回転軸の方向に沿って、光学系領域と、投光器、受光器及び信号処理回路が内部に配置されている駆動系領域と、に分割されるとともに、光学系領域の側壁は、光を透過する透明円筒で構成

され、光学系領域は、回転軸の方向に沿って、駆動系領域に隣接し、投光光路変換手段を内部に含んで照射光が検出方向へと出射される投光領域と、受光光路変換手段を内部に含んで反射光が検出方向から入射される受光領域と、にさらに分割されるとともに、投光領域と受光領域とは、透明円筒に対して固定されて設置され光路からはずれた迷光を遮光する遮光手段によって光学的に分割され、投光器は、回転軸上に投光光路変換手段に対向して配置され、受光領域内部に設置されて、受光光路変換手段からの反射光を受光器に導光する反射光導光手段を有することを特徴とする。

【００１０】上記の構成においては、回転機構の回転軸に沿った方向に関して、投光器及び受光器がともに光路変換手段である投光光路変換手段及び受光光路変換手段に対して同じ側にある駆動系領域に設置される。これによって、投光領域及び受光領域を含む光学系領域内における信号線などの配線をなくして、完全な３６０度の全方位距離検出を可能にし、設計上の自由度等を確保して装置の機能性を高めるとともに、信号処理回路への配線を短くして、受光信号等への電気的ノイズの影響を低減して距離の検出精度の劣化を抑制することができる。

【００１１】また、このような装置構成においては、投光器及び受光器の少なくとも一方は、回転機構の回転軸から外れた位置に配置される必要がある。この場合、投光器からの照射光を導光する照射光導光手段、または受光器への反射光を導光する反射光導光手段を設けることが必要となる。

【００１２】すなわち、受光器を回転軸上に配置する構成とした場合には、投光器は回転軸から外れた位置に配置されるが、上記したように投光器から投光光路変換手段へと照射光を導光する反射プリズムなどによる照射光導光手段を備えた構成とすることによって、投光及び受光が可能となる。

【００１３】また、投光器を回転軸上に配置する構成とし、受光器を回転軸から外れた位置に配置した場合には、受光光路変換手段から受光器へと反射光を導光する反射プリズムなどによる反射光導光手段を備えた構成とすることによって、投光及び受光が可能となる。

【００１４】さらに、角度検出手段は、回転部の外周に固定され、回転軸を中心とする所定の円上に等間隔に設けられた複数のスリットからなる角度検出スリット群を有する角度検出円盤と、スリットの通過を光電的に検出する光電ユニットと、所定の周波数を有する高速パルス状の電気信号を発生するクロック回路と、光電ユニットによるスリットの検出と、クロック回路による電気信号のパルス数とを用いて物体のある角度を演算する角度演算手段と、を備えることを特徴としても良い。

【００１５】上記のような装置においては、円盤及び光電ユニットを有する透過型光学式エンコーダによって物体のある角度を検出することが可能であるが、この場合、角度検出スリット群のスリットの配置間隔によって角度分解能が決まってしまうため、高分解能での角度検出を行うことができない。これに対して、高速パルスの電気信号による角度検出を併用することによって、スリットの配置間隔を変えることなく高分解能での角度検出が可能となる。

【００１６】

【発明の実施の形態】以下、図面と共に本発明による全方位距離検出装置の好適な実施形態について詳細に説明する。なお、図面の説明においては同一要素には同一符号を付し、重複する説明を省略する。また、図面の寸法比率は、説明のものと必ずしも一致していない。

【００１７】図１は、本発明に係る全方位距離検出装置の第１の実施形態の構成を示す断面図である。また、図２は、本実施形態の光学系の要素及び光路を概略的に示す斜視図である。なお、図２においては、後述する回転円筒４１及び遮光板４２を一部破断して示している。

【００１８】本実施形態におけるハウジング１は、駆動系カバー１１、区分板１２、透明円筒１３及び光学系カバー１４から構成されている。このハウジング１の内部領域は区分板１２によって、駆動系カバー１１を側壁とする下方の駆動系領域Ｒ１と、透明円筒１３を側壁として外部に対して光学的に開放された上方の光学系領域Ｒ２とに分割されている。

【００１９】区分板１２の中央部分には、鉛直方向を回転軸として回転駆動する回転部４０が、区分板１２に対して回転可能であるように接続されて設置されている。回転部４０の下部を構成し、区分板１２に接続されている回転支持部４０ａには、その外周の駆動系領域Ｒ１内に位置する所定の部位に円盤状の回転リング４５が設けられている。一方、回転部４０を駆動するためのモータを有して構成され、駆動系領域Ｒ１内の回転軸から外れた所定の位置に設置されている回転駆動部４３には、回転駆動軸４４を介して回転リング４６が設置されている。この回転リング４５及び４６が回転ベルト４７により接続されることによって回転機構が構成され、回転駆動部４３による回転部４０の回転駆動及びその制御が行われる。なお、回転支持部４０ａの内側には、所定の内径を有する円筒状の導光路４０ｂが形成されている。

【００２０】回転部４０の光学系領域Ｒ２内に位置する上部は、回転円筒４１によって構成されている。この回転円筒４１の内部には光路変換手段である光路変換プリズム４が、回転円筒４１に対して固定されて設置されている。この光路変換プリズム４は、その中心軸を回転部４０の回転軸と一致させて配置された四角柱形の上下の端面を４５度の角度で切除して得た形状を有している。

【００２１】これら２つの切除面は、上方の切除面が投光光路変換手段である投光反射面４ａ、また、下方の切除面が受光光路変換手段である受光反射面４ｂを構成し、これによって本実施形態における投光・受光の主光

路系が決定される。すなわち光学系領域Ｒ２は、光路変換プリズム４の投光反射面４ａ及び受光反射面４ｂに挟まれた水平面を境界面として、上方の投光領域Ｒ２ａと下方の受光領域Ｒ２ｂとに区分される。

【００２２】投光領域Ｒ２ａは投光反射面４ａを含み、物体への照射光は、回転部４０の回転軸に沿った鉛直上方の投光入射光路La_1によって投光反射面４ａに入射して、光路変換されて投光出射光路La_2に導かれる。一方、受光領域Ｒ２ｂは受光反射面４ｂを含み、物体からの反射光は、受光入射光路Lb_2によって受光反射面４ｂに入射して、光路変換されて回転軸に沿った鉛直下方の受光出射光路Lb_1に導かれる。

【００２３】このとき、投光出射光路La_2及び受光入射光路Lb_2は水平かつ互いに平行であり、これによって投光出射光路La_2からの照射光による物体からの反射光を受光入射光路Lb_2から取り込むことができる。

【００２４】回転円筒４１の上端及び下端は、それぞれ投光入射光路La_1が通過する上端開口部４１ａ、及び受光出射光路Lb_1が通過する下端開口部４１ｂであり、また、側面のうち投光出射光路La_2及び受光入射光路Lb_2との交点を含む所定の領域には側面開口部４１ｃが形成されている。これらの上端開口部４１ａ、下端開口部４１ｂ、及び側面開口部４１ｃにはそれぞれ光を透過する透明部材によって形成された光透過窓（図示していない）が設置される。なお、これらについては光透過窓を設置せずに開放された状態としても良い。

【００２５】また、投光出射光路La_2及び受光入射光路Lb_2が通過する、投光領域Ｒ２ａ及び受光領域Ｒ２ｂからなる光学系領域Ｒ２の側壁は、光を透過する透明円筒１３である。ここで、各光路は３６０度にわたって回転するため、光路とともに回転する回転円筒４１の一部領域に形成されている側面開口部４１ｃと異なり、側壁においてはこの透明円筒１３によって３６０度全方位が光学的に開放されている。なお、本実施形態においては、透明円筒１３の中心軸は回転部４０の回転軸と一致している。

【００２６】なお、光路変換プリズム４については、他の形状、例えばその中心軸を回転軸と一致させて配置された円柱形の上下の端面を４５度の角度で切除して得た形状のものを用いても良い。また、投光光路変換手段及び受光光路変換手段として、それぞれ別個に形成された反射ミラー等を用いる構成としても良い。

【００２７】投光領域Ｒ２ａ及び受光領域Ｒ２ｂの境界面には、中央に回転円筒４１が貫通する中央開口部４２ａを有する円盤状の遮光板４２が設置されている。遮光板４２は、その外周部の複数箇所において遮光板固定部４２ｃ（図１にはそのうちの１箇所が示されている）によって透明円筒１３に対して固定されている。これによって、照射光のハウジング１の内壁、透明円筒１３に付着したゴミ及び水滴などによる散乱・反射光である光路からはずれた迷光が受光領域Ｒ２ｂに入射するのを防いで、距離検出の精度低下を抑制することができる。

【００２８】本装置における照射光の投光及び反射光の受光はそれぞれ、好ましくは半導体レーザである投光器２、及び好ましくは半導体受光素子である受光器３によって行われる。これらの投光器２及び受光器３は、いずれも駆動系領域Ｒ１内に設置されている。このような構成とした場合、投光器２及び受光器３がいずれも光学系領域Ｒ２に対して下方に、特に遮光板４２が設置されている投光領域Ｒ２ａと受光領域Ｒ２ｂとの境界面に対して下方（同じ側）に配置されているため、投光器２及び受光器３の少なくとも一方は、回転部４０の回転軸から外れた位置に配置される必要がある。

【００２９】本実施形態においては受光領域Ｒ２ｂが駆動系領域Ｒ１に隣接しており、投光器２は回転軸から外れた所定の位置に、鉛直上方を光の出射軸として設置されている。区分板１２の投光器２に対向する部位には導光部２３が設置されている。また、遮光板４２の投光器２に対向する部位には開口部４２ｂが設けられており、これによって、投光器２から鉛直上方に出射された照射光は、導光部２３、受光領域Ｒ２ｂ及び開口部４２ｂ内を通過して投光領域Ｒ２ａに入射される。なお、開口部４２ｂには、投光領域Ｒ２ａ側の各部位からの散乱光等が開口部４２ｂを介して受光領域Ｒ２ｂ側に入射することを防ぐために、遮光板４２よりも厚い散乱光制限リング２４が設置されている。

【００３０】上記したように回転軸から外れた位置にある投光器２から鉛直上方に向けて出射された照射光は、投光領域Ｒ２ａの上端を形成する光学系カバー１４の下面側に固定された照射光導光手段であるプリズム２１及び２２によって反射され、その光路を回転軸に沿った鉛直下方に向かう投光入射光路La_1に変換されて、投光反射面４ａに入射される。

【００３１】一方、受光器３は回転軸上に設置されており、これによって、受光反射面４ｂによって受光出射光路Lb_1に光路変換された反射光は、受光レンズ３１を介して受光器３に入射される。なお、照射光の投光についても、例えば導光部２３内に投光レンズを設置する構成としても良い。

【００３２】これらの投光器２及び受光器３は、それぞれ投光制御回路２０及び受光制御回路３０によってその投光及び受光を駆動制御されている。投光器２及び受光器３は、さらに信号処理回路５に接続されている（ただし、接続の配線は図示していない）。これによって、投光器２の駆動信号と、受光器３の受光信号とが信号処理回路５に入力されて、受光の有無から検出方向における物体の有無が、また、投光及び受光の時間差等から物体までの距離が信号処理回路５において演算されて求められる。

【００３３】従来の全方位距離検出装置においては、投

光器及び受光器は光路変換手段に対してそれぞれ投光領域側及び受光領域側に、いずれも回転軸上に対向して配置されている。この場合、投光器及び受光器が回転軸のほぼ両端、したがって装置の両端に設置されるために信号線等の配線が長くなり、回転駆動を行う上での制限となるとともに、長い配線によって回転駆動系等からの電気的ノイズの影響を受けやすいという問題があった。

【００３４】これに対して、本発明による装置においては、投光領域Ｒ２ａ及び受光領域Ｒ２ｂからなる光学系領域Ｒ２とは別に、投光領域Ｒ２ａ側または受光領域Ｒ２ｂ側のどちらか一方（図１に示す実施形態においては受光領域Ｒ２ｂ側）に駆動系領域Ｒ１を設けて、投光器２、受光器３、及びそれらからの信号が入力される信号処理回路５をともにこの駆動系領域Ｒ１内に設置している。これによって、それら相互間の配線を短くして装置設計の自由度を確保し、かつ光学系領域Ｒ２内に配線が存在しないようにすることによって完全な３６０度にわたる全方位距離検出が可能となる。さらに、このように配線を短くすることによって、受光信号等への電気的ノイズの影響を抑制して距離検出の精度が向上された全方位距離検出装置を実現することができる。また、このように投光器２及び受光器３を同じ領域に配置することによって、装置の小型化も実現できる。

【００３５】さらに、本実施形態に示すように、投光器２、受光器３、回転駆動部４３等が設置されている駆動系領域Ｒ１が装置下方に位置する場合、光学系領域Ｒ２の側壁である透明円筒１３によって支える装置部分の重量が低減されるので、透明円筒１３の厚さを薄くした場合においても充分な強度を得ることができる。これによって、照射光の投光出射光路La_2による出射及び反射光の受光入射光路Lb_2による入射時において、透過光量の減少及び像の歪みを抑制することができ、より精度の高い距離検出が可能となる。

【００３６】また、本装置においては、遮光板４２がハウジング１の側壁である透明円筒１３に対して固定されている。投光領域及び受光領域を分離する遮光手段が回転部に対して固定されている場合には、遮光手段をも回転させる構造となるため、回転駆動の負荷が増加する。これに対して、遮光板４２をハウジング１に対して固定する構造とすることによって、回転駆動の機能性をより高めることができる。このような遮光板４２の固定配置は、投光器２、受光器３及びプリズム２１、２２等が固定配置されていることによって可能となる。同時にこれらの固定配置によって、装置における光軸調整等を容易化することができる。

【００３７】また、投光領域Ｒ２ａ及び受光領域Ｒ２ｂが遮光板４２のみを介して隣接していることによって、近距離測定においても受光見込み角から外れることによる受光効率の低下が抑制される。

【００３８】次に、本装置における角度検出手段と、それによる物体のある角度の検出について説明する。回転支持部４０ａの光学系領域Ｒ２内に位置する部位には、エンコーダ円盤５１が取り付けられており、その外周上の所定の位置には、エンコーダ円盤５１の外周の一部を挟み込むように光電ユニット５２が区分板１２に固定されて設置されている。このエンコーダ円盤５１、光電ユニット５２、及びこれらを制御するエンコーダ制御回路５３によって、角度検出のための透過型光学式エンコーダが構成されている。

【００３９】エンコーダ円盤５１には、回転部４０の回転軸を中心とし、回転時に光電ユニット５２の内側を通過する領域内にある所定の円上に、所定の角度間隔で配置された複数のスリットからなる角度検出スリット群が形成されている。また、同様に回転時に光電ユニット５２の内側を通過する領域内にあって上記の角度検出スリット群とは異なる同心円上に、基準角度検出スリットが形成されている。この基準角度検出スリットは、角度検出スリット群による角度検出の基点となる角度位置を決定するために設けられるものであり、回転部４０の回転速度などの諸条件に応じて単一のスリットからなるか、または、１８０度間隔の２つのスリットもしくは９０度間隔の４つのスリットなどの複数のスリットから構成される。

【００４０】光電ユニット５２には、エンコーダ円盤５１を挟んで一方に発光素子が、他方に受光素子が配置されており、これによって角度検出スリット群の各スリット、及び基準角度検出スリットを透過した発光素子からの光を受光素子によって検出して、角度情報を得ることができる。なお、このような光による角度検出を行うため、光電ユニット５２を含む領域を囲むように遮光ケース５４が設置されている。

【００４１】この透過型光学式エンコーダからの信号は、信号処理回路５に入力されて、物体のある角度の演算が行われる。この場合においても、光電ユニット５２等は駆動系領域Ｒ１に隣接して設置されており、したがって、その信号線等の配線はすべて駆動系領域Ｒ１内において行われる。これによって、距離検出に関する信号線と同様に、角度検出に関する信号線を短くして電気的ノイズの影響による分解能の劣化を低減することができる。なお、図示していないが、区分板１２の遮光ケース５４によって覆われた領域内の所定の部位には、透過型光学式エンコーダからの信号線を配線するための配線路が設けられている。

【００４２】上記したような透過形光学式エンコーダを用いた場合、角度検出スリット群のスリットの配置間隔によって角度検出の分解能が決定される。より高分解能での角度検出を行うにはスリットの配置間隔を小さくする必要があるが、スリット配置の高密度化は限界があり、また、エンコーダ円盤５１の径を大きくしたのでは、装置自体が大型化してしまう。そこで発明者らは、

透過型光学式エンコーダによる角度検出と、電気クロックによる検出とを併用することによって、角度分解能を高くする角度検出方法を採用した（例えば特開平５－６０５７５号）。

【００４３】図３は、上記した角度検出方法を説明するためのタイミング図であり、角度検出スリット群に対応する光学信号、及び角度検出に併用される所定の周波数による電気信号を示してある。本実施形態においては、信号処理回路５は所定の周波数を有する高速パルス状の電気信号を発生するクロック回路と、この電気信号を併用して角度の演算を行う角度演算回路を含んで構成されている。クロック回路によって発生される電気信号の周波数は、角度検出スリット群のスリット配置間隔及び回転部４０の回転速度によって決まる光学信号の信号パルス間隔に対してその信号パルス間隔が小さくなるように設定されている。また、例えば光学信号における信号パルスS_nは、基準角度検出スリットによって検出された基準角度からｎ番目のスリットによる信号パルスを示し、角度検出スリット群のスリット配置間隔をθ_0として、角度$n\theta_0$に相当している。

【００４４】ここで、回転部４０が一定速度で回転している場合を考えると、隣接するスリットに対応する２つの信号パルスＳ間の電気信号パルスの個数は一定である。この個数は、例えば信号パルスS_n～S_{n+1}間においてN_0個と測定によって求められる。このとき、電気信号パルス１個当たりの角度間隔はθ_0/N_0であり、これによって、この角度間隔θ_0/N_0を角度分解能とした高分解能での測定が可能となる。すなわち、例としてタイミングＴにおいて物体からの反射光を受光したとし、そのときの信号パルスS_{n+1}からの電気信号パルスの個数がN_1個であったとすると、検出された物体の角度は$(n+1+N_1/N_0)\ \theta_0$と求められる。

【００４５】特に、このような電気信号パルスを併用した角度検出方法を用いることによって、上記したようにスリット配置間隔よりも高い角度分解能による測定が可能になる。また、電気信号パルスの周波数を変更することによって、スリット配置間隔を変更することなくその角度検出の分解能を変更することが可能となる。

【００４６】本発明による全方位距離検出装置は、上記した実施形態に限られるものではなく、様々に変形が可能である。

【００４７】図４は、本発明に係る全方位距離検出装置の第２の実施形態の構成を示す断面図である。本実施形態においては、光学系領域Ｒ２の側壁である透明円筒は、２つの透明円筒、すなわち投光領域Ｒ２ａの側壁である透明円筒１３ａ及び受光領域Ｒ２ｂの側壁である透明円筒１３ｂによって構成され、遮光板４２はこれらの透明円筒１３ａ及び１３ｂに挟まれて設置されている。このような構成によっても、第１の実施形態と同様の効果を得ることができる。なお、本実施形態においては、遮光板４２の厚さが第１の実施形態によるものよりも厚く形成されており、そのため、開口部４２ｂには散乱光制限リングは設置されていない。

【００４８】図５は、本発明に係る全方位距離検出装置の第３の実施形態の構成を示す断面図である。本実施形態においては、投光器２及び導光部２３は鉛直軸に対して所定の角度傾けて設置されており、これによって光学系カバー１４に固定された単一のプリズム２１を照射光導光手段として、照射光の導光が行われる。この場合、プリズム２１が単一であることによって、光軸調整が簡単化される。

【００４９】上記した第１～第３の実施形態は、すべて受光器を回転機構の回転軸上に配置しているが、逆に投光領域が駆動系領域に隣接するように光学系領域の分割を行い、投光器を回転軸上に投光光路変換手段に対向するように配置する構成とすることも可能である。このとき、受光器は回転軸から外れた位置に配置されて、受光光路変換手段から受光器へ向けて反射光を導光する単一または複数の反射プリズムなどからなる反射光導光手段を備えることによって投光及び受光が行われる。この場合、反射光は照射光に比べてスポット径が大きいため、導光手段における光軸調整が比較的容易である。また、反射光を通過させる遮光板上の開口部については、照射光の場合に比べて、反射光を充分に取り入れるために大きくする必要がある。

【００５０】

【発明の効果】本発明による全方位距離検出装置は、以上詳細に説明したように、次のような効果を得る。すなわち、投光領域及び受光領域からなる光学系領域の一方側に、投光器、受光器及び信号処理回路がともに設置される領域である駆動系領域を設けた構成とすることによって、それら相互間の信号線等の配線が光学系領域内を通過しないようにして完全な３６０度の全方位距離検出が可能な全方位距離検出装置とすることができる。

【００５１】また、これによって配線の距離が短縮されるので、回転機構の駆動系等に起因する受光信号等への電気的ノイズの影響が抑制され、距離検出の精度を向上させることができる。

【図面の簡単な説明】

【図１】本発明に係る全方位距離検出装置の第１の実施形態の構成を示す断面図である。

【図２】図１に示す全方位距離検出装置の光学系を概略的に示す斜視図である。

【図３】図１に示す全方位距離検出装置による物体のある角度の検出方法を説明するタイミング図である。

【図４】本発明に係る全方位距離検出装置の第２の実施形態の構成を示す断面図である。

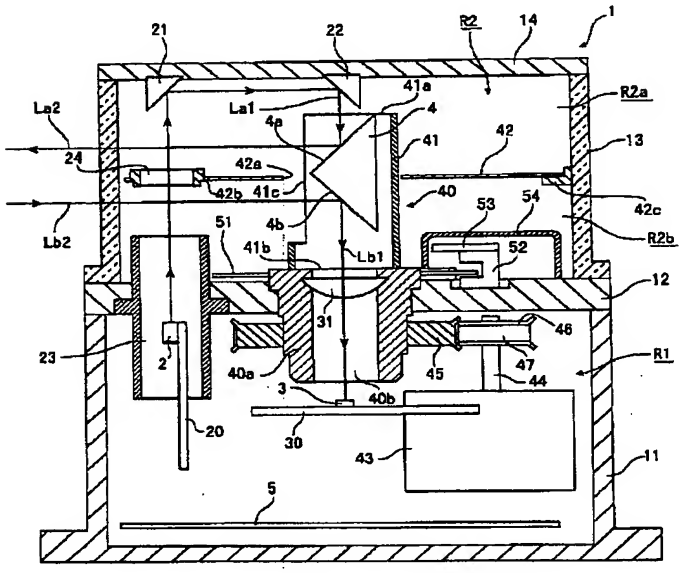
【図５】本発明に係る全方位距離検出装置の第３の実施形態の構成を示す断面図である。

【符号の説明】

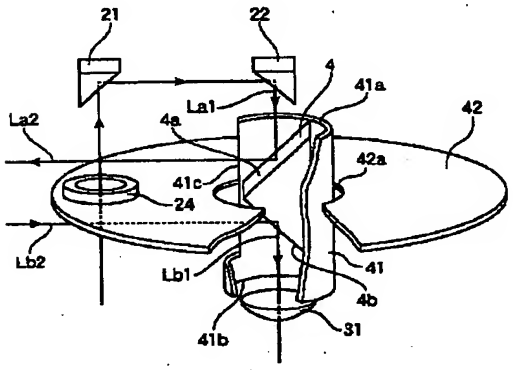
１…ハウジング、１１…駆動系カバー、１２…区分板、１３、１３ａ、１３ｂ…透明円筒、１４…光学系カバー、２…投光器、２０…投光制御回路、２１、２２…プリズム、２３…導光部、２４…散乱光制限リング、３…受光器、３０…受光制御回路、３１…受光レンズ、４…光路変換プリズム、４ａ…投光反射面、４ｂ…受光反射面、４０…回転部、４０ａ…回転支持部、４０ｂ…導光路、４１…回転円筒、４１ａ…上端開口部、４１ｂ…下端開口部、４１ｃ…側面開口部、４２…遮光板、４２ａ＊

＊…中央開口部、４２ｂ…開口部、４２ｃ…遮光板固定部、４３…回転駆動部、４４…回転駆動軸、４５、４６…回転リング、４７…回転ベルト、５…信号処理回路、５１…エンコーダ円盤、５２…光電ユニット、５３…エンコーダ制御回路、５４…遮光ケース、Ｒ１…駆動系領域、Ｒ２…光学系領域、Ｒ２ａ…投光領域、Ｒ２ｂ…受光領域、　Ｌａ$_1$…投光入射光路、Ｌａ$_2$…投光出射光路、Ｌｂ$_1$…受光出射光路、Ｌｂ$_2$…受光入射光路。

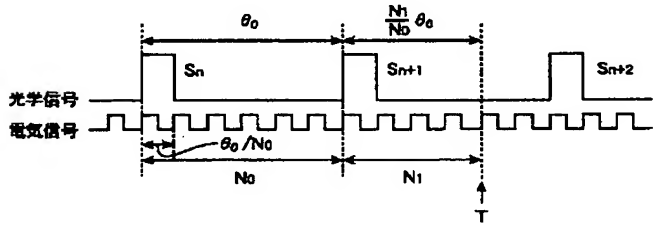
【図１】



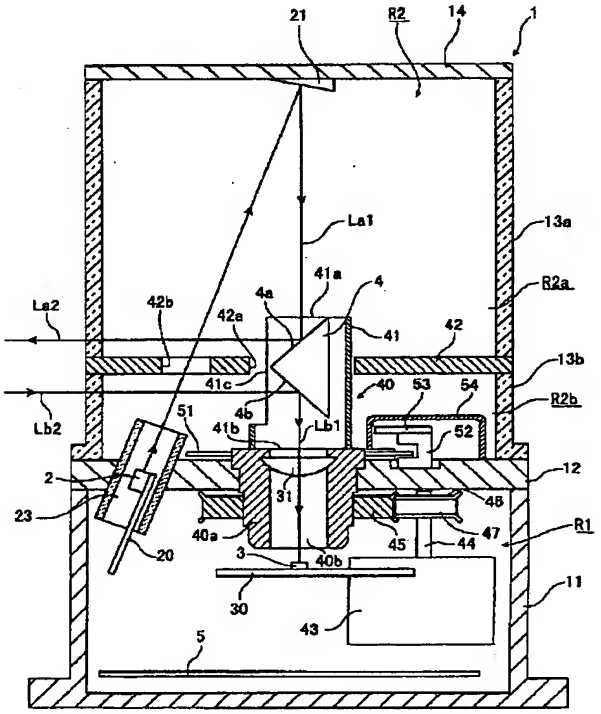
【図２】



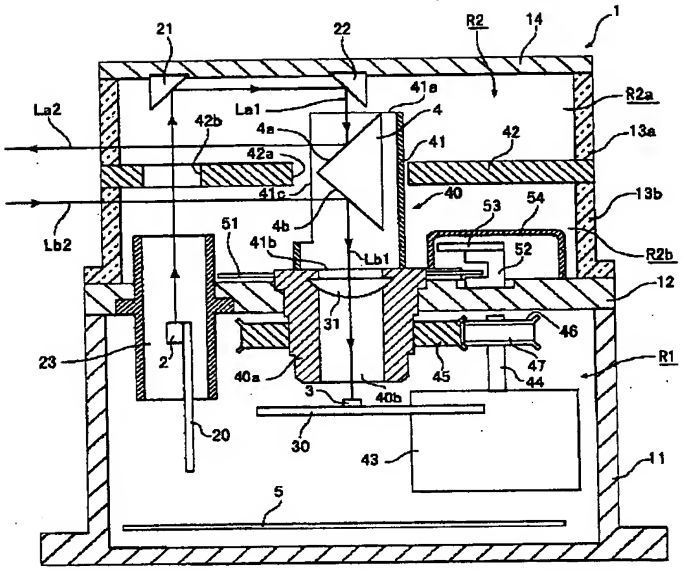
【図３】



【図５】



【図４】



フロントページの続き

(72)発明者　戸塚　弘倫
静岡県浜松市市野町1126番地の１　浜松ホトニクス株式会社内
(72)発明者　平柳　通人
静岡県浜松市市野町1126番地の１　浜松ホトニクス株式会社内

Ｆターム(参考)　2F065 AA06 AA31 DD03 FF12 GG04 HH04 JJ01 LL12 LL21 LL63 MM15
2F069 AA02 AA71 BB21 DD19 GG07 GG31 GG62 JJ10
2F112 AA03 AD01 BA06 CA05 DA25 EA05
5J084 AA05 AA10 AC02 BA04 BA11 BA36 BB02 BB11 BB37 CA03 DA01 DA09 EA04

PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2000-162318
(43)Date of publication of application : 16.06.2000

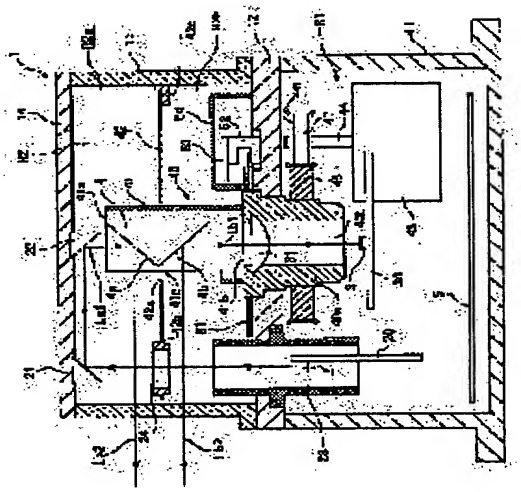
(51)Int.CI. G01S 17/08
G01B 11/00
G01B 21/22
G01C 3/06
G01S 7/48

(21)Application number : 10-333072
(22)Date of filing : 24.11.1998

(71)Applicant : HAMAMATSU PHOTONICS KK
(72)Inventor : NAKASE SHIGEKI
KAWAI TAKAAKI
TOTSUKA HIROTOMO
HIRAYANAGI MICHIHITO

(54) ALL DIRECTION DISTANCE DETECTOR

(57)Abstract:
PROBLEM TO BE SOLVED: To provide an all direction distance detector capable of accurately detecting a distance at 360 degrees.
SOLUTION: A driving region R1 of a region for installing all a light emitting unit 2, a light receiving unit 3 and a signal processor 5 is provided at one side of an optical region R2 having a light emitting region R2a and a light receiving region R2b. Thus, signal lines or the like between the regions R2a and R2b do not pass through the region R2 to provide an all direction distance detector capable of completely detecting all direction distances at 360 degrees. Thus, since a distance of wirings is shortened, an influence of an electric noise to a light receiving signal or the like caused by a driving system or the like of a rotating mechanism is suppressed, thereby improving an accuracy of detecting the distance.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] Equip the interior of housing with a projector and an electric eye, and outgoing radiation of the exposure light from said projector is carried out in the predetermined detection direction of said housing exterior through a floodlighting optical-path conversion means. In the distance detection equipment which carries out incidence of the reflected light from the body of said detection direction to said electric eye through a light-receiving optical-path conversion means, and detects the existence of said body, and the distance to said body The rotation section installed pivotable considering the predetermined shaft inside said housing as a revolving shaft, The rolling mechanism by which it has the rotation mechanical component which makes said rotation section drive, and is constituted, and said floodlighting optical-path conversion means and said light-receiving optical-path conversion means are fixed and installed on said revolving shaft, An include-angle detection means to detect angle of rotation of said rotation section, and detection of the distance to said body by the signal from said projector and said electric eye, While having the digital disposal circuit which performs detection of an include angle with said body by the signal from said include-angle detection means, the field inside said housing While being divided into an optical-system field and the drive-system field to which said projector, said electric eye, and said digital disposal circuit are arranged inside along the direction of said revolving shaft The side attachment wall of said optical-system field consists of transparence cylinders which penetrate light. Said optical-system field The floodlighting field where said floodlighting optical-path conversion means is included inside, and outgoing radiation of said exposure light is carried out in said detection direction along the direction of said revolving shaft, While resembling the light-receiving field where said drive-system field is adjoined, said light-receiving optical-path conversion means is included inside, and incidence of said reflected light is carried out from [said] detection and divided further Said floodlighting field and said light-receiving field are optically divided by protection-from-light means to shade the stray light which was fixed, was installed to said transparence cylinder and shifted from the optical path. Said electric eye Omnidirection distance detection equipment characterized by countering said light-receiving optical-path conversion means, being arranged on said revolving shaft, being installed in the interior of said floodlighting field, and having the exposure photoconductive light means which carries out the light guide of said exposure light from said projector to said floodlighting optical-path conversion means.
[Claim 2] Equip the interior of housing with a projector and an electric eye, and outgoing radiation of the exposure light from said projector is carried out in the predetermined detection direction of said housing exterior through a floodlighting optical-path conversion means. In the distance detection equipment which carries out incidence of the reflected light from the body of said detection direction to said electric eye through a light-receiving optical-path conversion means, and detects the existence of said body, and the distance to said body The rotation section installed pivotable considering the predetermined shaft inside said housing as a revolving shaft, The rolling mechanism by which it has the rotation mechanical component which makes said rotation section drive, and is constituted, and said floodlighting optical-path conversion means and said light-receiving optical-path conversion means are fixed and installed on said revolving shaft, An include-angle detection means to detect angle of rotation of said rotation section, and detection of the distance to said body by the signal from said projector and said electric eye, While having the digital disposal circuit which performs detection of an include angle with said body by the signal from said include-angle detection means, the field inside said housing While being divided into an optical-system field

and the drive-system field to which said projector, said electric eye, and said digital disposal circuit are arranged inside along the direction of said revolving shaft The side attachment wall of said optical-system field consists of transparence cylinders which penetrate light. Said optical-system field The floodlighting field where said drive-system field is adjoined, said floodlighting optical-path conversion means is included inside along the direction of said revolving shaft, and outgoing radiation of said exposure light is carried out in said detection direction, While resembling the light-receiving field where said light-receiving optical-path conversion means is included inside, and incidence of said reflected light is carried out from [said] detection and divided further, said floodlighting field and said light-receiving field It is fixed to said transparence cylinder and is optically divided by protection-from-light means to shade the stray light which was installed and shifted from the optical path. Said projector Omnidirection distance detection equipment characterized by countering said floodlighting optical-path conversion means, being arranged on said revolving shaft, being installed in the interior of said light-receiving field, and having the reflected light light guide means which carries out the light guide of said reflected light from said light-receiving optical-path conversion means to said electric eye.
[Claim 3] The include-angle detection disk which has the include-angle detection slit group which consists of two or more slits which said include-angle detection means was fixed to the periphery of said rotation section, and were prepared at equal intervals on the predetermined circle centering on said revolving shaft, The photoelectrical unit which detects passage of said slit in photoelectricity, and the clock circuit which generates the electrical signal of the shape of a high-speed pulse which has a predetermined frequency, Omnidirection distance detection equipment according to claim 1 or 2 characterized by having an include-angle operation means to calculate the include angle which has a body using detection of said slit by said photoelectrical unit, and the pulse number of said electrical signal by said clock circuit.

[Translation done.]

* NOTICES *

JPO and NCIPI are not responsible for any damages caused by the use of this translation.

1.This document has been translated by computer. So the translation may not reflect the original precisely.

2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the omnidirection distance detection equipment which can detect the include angle which has objective existence, the distance to a body, and a body over 360 perimeters.
[0002]
[Description of the Prior Art] As a distance sensor system carried in the former, for example, an automatic guided vehicle, it has outside a projector using laser, light emitting diode, etc. which are made to generate the exposure light by which outgoing radiation is carried out, and an electric eye using the photodiode which detects the reflected light from a body, it is constituted, and the distance detection equipment which detects the distance from the time difference of floodlighting and light-receiving etc. to a body is known by the existence of light-receiving in the existence of the body in the detection direction again.
[0003] The detection direction in such equipment is a direction where floodlighting of the exposure light to the exterior and light-receiving of the reflected light from the outside are performed. This detection direction can be chosen by changing the optical path of the reflected light by which incidence is carried out into the exposure light by which outgoing radiation is carried out, and an electric eye from a projector in the predetermined direction with reflective means, such as a reflective mirror which is an optical-path conversion means. It is possible over about 360 perimeters rotation and to make the detection direction

change by enabling continuous modification of the detection direction here as a configuration fixed and installed by the pivotable rolling mechanism with a predetermined revolving shaft in an optical-path conversion means, and considering as the configuration which turned outside the side attachment wall of the perimeter which an optical-path conversion means rotates, and was opened wide optically. By this, it can consider as the distance detection equipment of the omnidirection mold which can detect distance to a body about an omnidirection.

[0004] In omnidirection distance detection equipment which was described above, the location of the detected body can be pinpointed by detecting an include angle (direction) with a body in addition to detection of the distance to the body by floodlighting and light-receiving. That is, while the existence of light-receiving of the reflected light from a body detects objective existence, when the reflected light is received and a body exists, include-angle detection means, such as a transparency mold optical encoder installed [distance / to a body] to the rolling mechanism again in angle of rotation of the detection direction according to the time difference of floodlighting and light-receiving etc. so that it might be measurable, detect an include angle with a body. As such equipment, there is equipment indicated by JP,7-191142,A and JP,10-10233,A, for example.

[0005]

[Problem(s) to be Solved by the Invention] In the above-mentioned conventional omnidirection distance detection equipment, to the optical-path conversion means currently fixed on the revolving shaft, a projector and an electric eye counter on the revolving shaft, and they are arranged so that the predetermined reflector of an optical-path conversion means may be faced, respectively. That is, a projector is arranged in one edge of a revolving shaft, outgoing radiation of the exposure light is carried out in accordance with a revolving shaft, by optical-path conversion means, such as a floodlighting mirror, an optical path is changed in the detection direction which is a perpendicular direction to a revolving shaft, and outgoing radiation is carried out outside. On the other hand, an electric eye is arranged at the other-end section of a revolving shaft, an optical path is changed in the direction in which the reflected light from [from detection] the body by which incidence is carried out met the revolving shaft with optical-path conversion means, such as a light-receiving mirror, and incidence is carried out to an electric eye.

[0006] In the equipment by such configuration, since [of a revolving shaft] it was mostly installed in both ends, therefore the both ends of equipment, wiring of a signal line etc. became [the projector and the electric eye] long, and there was a problem that the degree of freedom on the design of a rolling mechanism etc. will be restricted by this wiring. Moreover, since this wiring needed to pass through the inside of the field where floodlighting of the exposure light to the exterior and light-receiving of the reflected light from the outside are performed, 360 perfect omnidirection distance detection was impossible. Furthermore, such long wiring increases the effect of the electrical noise from the rotation drive system of a rolling mechanism etc., and also becomes the cause of degrading the precision of distance detection.

[0007] This invention is made in view of the above-mentioned trouble, and aims at offering the omnidirection distance detection equipment in which distance detection with high degree of accuracy is possible over 360 degrees.

[0008]

[Means for Solving the Problem] In order to attain such a purpose, the omnidirection distance detection equipment by this invention Equip the interior of housing with a projector and an electric eye, carry out outgoing radiation of the exposure light from a projector in the predetermined detection direction of the housing exterior through a floodlighting optical-path conversion means, and incidence of the reflected light from the body of the detection direction is carried out to an electric eye through a light-receiving optical-path conversion means. The rotation section installed pivotable considering the predetermined shaft inside housing as a revolving shaft in the distance detection equipment which detects objective existence and the distance to a body, The rolling mechanism by which it has the rotation mechanical component which makes the rotation section drive, and is constituted, and a floodlighting optical-path conversion means and a light-receiving optical-path conversion means are fixed and installed on a revolving shaft, While having the digital disposal circuit which performs an include-angle detection means to detect angle of rotation of the rotation section, detection of the distance to the body by the signal from a projector and an electric eye, and detection of an include angle with the body by the signal from an include-angle detection means While the field inside housing is divided into the drive-system field to which the optical-system field, a projector and an electric eye, and the digital disposal circuit are arranged inside along the direction of a revolving shaft The side attachment wall of an optical-system field consists of transparence cylinders which penetrate light. An optical-system field The floodlighting field where a floodlighting optical-path conversion

means is included inside, and outgoing radiation of the exposure light is carried out in the detection direction along the direction of a revolving shaft, While resembling the light-receiving field where a drive-system field is adjoined, a light-receiving optical-path conversion means is included inside, and incidence of the reflected light is carried out from detection and divided further, a floodlighting field and a light-receiving field It is fixed to a transparence cylinder and is optically divided by protection-from-light means to shade the stray light which was installed and shifted from the optical path. An electric eye It is characterized by countering a light-receiving optical-path conversion means, being arranged on a revolving shaft, being installed in the interior of a floodlighting field, and having the exposure photoconductive light means which carries out the light guide of the exposure light from a projector to a floodlighting optical-path conversion means.

[0009] Moreover, equip the interior of housing with a projector and an electric eye, carry out outgoing radiation of the exposure light from a projector in the predetermined detection direction of the housing exterior through a floodlighting optical-path conversion means, and incidence of the reflected light from the body of the detection direction is carried out to an electric eye through a light-receiving optical-path conversion means. The rotation section installed pivotable considering the predetermined shaft inside housing as a revolving shaft in the distance detection equipment which detects objective existence and the distance to a body, The rolling mechanism by which it has the rotation mechanical component which makes the rotation section drive, and is constituted, and a floodlighting optical-path conversion means and a light-receiving optical-path conversion means are fixed and installed on a revolving shaft, While having the digital disposal circuit which performs an include-angle detection means to detect angle of rotation of the rotation section, detection of the distance to the body by the signal from a projector and an electric eye, and detection of an include angle with the body by the signal from an include-angle detection means While the field inside housing is divided into the drive-system field to which the optical-system field, a projector and an electric eye, and the digital disposal circuit are arranged inside along the direction of a revolving shaft The side attachment wall of an optical-system field consists of transparence cylinders which penetrate light. An optical-system field The floodlighting field where a drive-system field is adjoined, a floodlighting optical-path conversion means is included inside along the direction of a revolving shaft, and outgoing radiation of the exposure light is carried out in the detection direction, While resembling the light-receiving field where a light-receiving optical-path conversion means is included inside, and incidence of the reflected light is carried out from detection and divided further, a floodlighting field and a light-receiving field It is fixed to a transparence cylinder and is optically divided by protection-from-light means to shade the stray light which was installed and shifted from the optical path. A projector It is characterized by countering a floodlighting optical-path conversion means, being arranged on a revolving shaft, being installed in the interior of a light-receiving field, and having the reflected light light guide means which carries out the light guide of the reflected light from a light-receiving optical-path conversion means to an electric eye.

[0010] In the above-mentioned configuration, it is installed in the drive-system field which is in the same side to the floodlighting optical-path conversion means and the light-receiving optical-path conversion means which both a projector and an electric eye are optical-path conversion means about the direction in alignment with the revolving shaft of a rolling mechanism. By this, while losing wiring of the signal line in an optical-system field including a floodlighting field and a light-receiving field etc., enabling 360 perfect omnidirection distance detection, securing the degree of freedom on a design etc. and raising the functionality of equipment, wiring to a digital disposal circuit can be shortened, the effect of the electrical noise to a light-receiving signal etc. can be reduced, and degradation of the detection precision of distance can be controlled.

[0011] Moreover, in such an equipment configuration, either [at least] a projector or an electric eye needs to be arranged in the location from which it separated from the revolving shaft of a rolling mechanism. In this case, it is necessary to establish the exposure photoconductive light means which carries out the light guide of the exposure light from a projector, or the reflected light light guide means which carries out the light guide of the reflected light to an electric eye.

[0012] That is, when it considers as the configuration which arranges an electric eye on a revolving shaft, although a projector is arranged in the location from which it separated from the revolving shaft, floodlighting and light-receiving of it are attained by considering as the configuration equipped with the exposure photoconductive light means by the reflecting prism which carries out the light guide of the exposure light from a projector to a floodlighting optical-path conversion means as described above.

[0013] Moreover, floodlighting and light-receiving are attained by considering as the configuration which arranges a projector on a revolving shaft, and considering as the configuration equipped with the reflected

light light guide means by the reflecting prism which carries out the light guide of the reflected light from a light-receiving optical-path conversion means to an electric eye, when it has arranged in the location which separated from the electric eye from the revolving shaft.
[0014] Furthermore, the include-angle detection disk which has the include-angle detection slit group which consists of two or more slits which the include-angle detection means was fixed to the periphery of the rotation section, and were prepared at equal intervals on the predetermined circle centering on a revolving shaft, The photoelectrical unit which detects passage of a slit in photoelectricity, and the clock circuit which generates the electrical signal of the shape of a high-speed pulse which has a predetermined frequency, It is good also considering having an include-angle operation means to calculate the include angle which has a body using detection of the slit by the photoelectrical unit, and the pulse number of the electrical signal by the clock circuit as a description.
[0015] In the above equipments, although it is possible to detect an include angle with a body with the transparency mold optical encoder which has a disk and a photoelectrical unit, since angular resolution is decided by arrangement spacing of the slit of an include-angle detection slit group in this case, include-angle detection by the high resolution cannot be performed. On the other hand, the include-angle detection by the high resolution is attained by using together the include-angle detection by the electrical signal of a high-speed pulse, without changing arrangement spacing of a slit.
[0016]
[Embodiment of the Invention] Hereafter, the suitable operation gestalt of the omnidirection distance detection equipment by this invention is explained to a detail with a drawing. In addition, in explanation of a drawing, the same sign is given to the same element, and the overlapping explanation is omitted. Moreover, the dimension ratio of a drawing is not necessarily in agreement with the thing of explanation.
[0017] Drawing 1 is the sectional view showing the configuration of the 1st operation gestalt of the omnidirection distance detection equipment concerning this invention. Moreover, drawing 2 R> 2 is the perspective view showing roughly the element and optical path of optical system of this operation gestalt. In addition, in drawing 2 , the rotation cylinder 41 and gobo 42 which are mentioned later are fractured in part, and are shown.
[0018] The housing 1 in this operation gestalt consists of the drive-system covering 11, a partition plate 12, a transparence cylinder 13, and optical-system covering 14. The contrant region of this housing 1 is divided into the drive-system field R1 of the lower part which uses drive-system covering 11 as a side attachment wall, and the upper optical-system field R2 wide opened optically to the exterior by using the transparence cylinder 13 as a side attachment wall by the partition plate 12.
[0019] By setting a revolving shaft as the direction of a vertical, to the partition plate 12, it connects and the rotation section 40 which carries out a rotation drive is installed in the central part of the partition plate 12 so that it may be pivotable. The lower part of the rotation section 40 is constituted and the disc-like rotation ring 45 is formed in the predetermined part located in the drive-system field R1 of the periphery at rotation supporter 40a connected to the partition plate 12. On the other hand, it has a motor for driving the rotation section 40, and is constituted, and the rotation ring 46 is installed in the rotation mechanical component 43 currently installed in the position from which it separated from the revolving shaft in the drive-system field R1 through the rotation driving shaft 44. When these rotation rings 45 and 46 are connected by the rotation belt 47, a rolling mechanism is constituted and a rotation drive and its control of the rotation section 40 by the rotation mechanical component 43 are performed. In addition, inside rotation supporter 40a, cylinder-like light guide line 40b which has a predetermined bore is formed.
[0020] The upper part located in the optical-system field R2 of the rotation section 40 is constituted by the rotation cylinder 41. The optical-path conversion prism 4 which is an optical-path conversion means is fixed and installed in the interior of this rotation cylinder 41 to the rotation cylinder 41. This optical-path conversion prism 4 has the configuration where the end face of the upper and lower sides of the square pole form which that medial axis was made in agreement with the revolving shaft of the rotation section 40, and has been arranged was excised and obtained at the include angle of 45 degrees.
[0021] These two excision sides constitute floodlighting reflector 4a whose upper excision side is a floodlighting optical-path conversion means, and light-receiving reflector 4b whose downward excision side is a light-receiving optical-path conversion means, and the main optical-path system of the floodlighting and light-receiving in this operation gestalt is determined by this. Namely, the optical-system field R2 is classified into upper floodlighting field R2a and downward light-receiving field R2b by making into an interface the horizontal plane inserted into floodlighting reflector 4a of the optical-path conversion prism 4, and light-receiving reflector 4b.
[0022] Incidence of the exposure light to a body is carried out to floodlighting reflector 4a, optical-path

conversion is carried out by the floodlighting incident light way La1 of the vertical upper part where floodlighting field R2a met the revolving shaft of the rotation section 40 including floodlighting reflector 4a, and it is led to the floodlighting outgoing radiation optical path La2. On the other hand, light-receiving field R2b is led to the light-receiving outgoing radiation optical path Lb1 of the vertical lower part to which incidence was carried out to light-receiving reflector 4b by the light-receiving incident light way Lb2, optical-path conversion was carried out, and the reflected light from a body met the revolving shaft including light-receiving reflector 4b.

[0023] At this time, the floodlighting outgoing radiation optical path La2 and the light-receiving incident light way Lb2 are mutually [horizontally and] parallel, and the reflected light from the body by the exposure light from the floodlighting outgoing radiation optical path La2 can be incorporated from the light-receiving incident light way Lb2 by this.

[0024] The upper limit and lower limits of the rotation cylinder 41 are upper limit opening 41a which the floodlighting incident light way La1 passes, respectively, and lower limit opening 41b which the light-receiving outgoing radiation optical path Lb1 passes, and side-face opening 41c is formed in the predetermined field which includes an intersection with the floodlighting outgoing radiation optical path La2 and the light-receiving incident light way Lb2 among side faces. The light transmission aperture (not shown) formed of the transparence member which penetrates light, respectively is installed in such upper limit opening 41a, lower limit opening 41b, and side-face opening 41c. In addition, about these, it is good also as a condition opened wide, without installing a light transmission aperture.

[0025] Moreover, the side attachment wall of the optical-system field R2 which consists of floodlighting field R2a and light-receiving field R2b which the floodlighting outgoing radiation optical path La2 and the light-receiving incident light way Lb2 pass is the transparence cylinder 13 which penetrates light. Here, in order to rotate each optical path over 360 degrees, unlike side-face opening 41c of the rotation cylinder 41 which rotates with an optical path currently formed in the field in part, in the side attachment wall, the omnidirection is wide opened optically 360 degrees with this transparence cylinder 13. In addition, in this operation gestalt, the medial axis of the transparence cylinder 13 is in agreement with the revolving shaft of the rotation section 40.

[0026] In addition, about the optical-path conversion prism 4, the thing of other configurations, for example, the configuration where the end face of the upper and lower sides of the cylindrical shape which the medial axis was made in agreement with a revolving shaft, and has been arranged was excised and obtained at the include angle of 45 degrees, may be used. Moreover, it is good also as a configuration using the reflective mirror formed separately, respectively as a floodlighting optical-path conversion means and a light-receiving optical-path conversion means.

[0027] In the interface of floodlighting field R2a and light-receiving field R2b, the disc-like gobo 42 which has central opening 42a which the rotation cylinder 41 penetrates is installed in the center. The gobo 42 is being fixed by gobo fixed part 42c (one of places [them] is shown in drawing 1) to the transparence cylinder 13 in two or more places of the periphery section. By this, from the optical path which are dispersion and the reflected light by dust, waterdrop, etc. adhering to the wall of the housing 1 of exposure light, and the transparence cylinder 13, it can prevent the stray light shifted carrying out incidence to light-receiving field R2b, and the precision fall of distance detection can be controlled.

[0028] Floodlighting of the exposure light in this equipment and light-receiving of the reflected light are preferably performed by the projector 2 which is semiconductor laser, and the electric eye 3 which is a semi-conductor photo detector preferably, respectively. These projectors 2 and electric eyes 3 are installed by each in the drive-system field R1. When it considers as such a configuration, it needs to be arranged in the location where they separated from the revolving shaft of the rotation section 40 from either [at least] the projector 2 or the electric eye 3 since the projector 2 and the electric eye 3 were arranged below (the same side) by each to the interface of floodlighting field R2a in which especially the gobo 42 is installed caudad, and light-receiving field R2b to the optical-system field R2.

[0029] In this operation gestalt, light-receiving field R2b adjoins the drive-system field R1, and the projector 2 is installed in the position from which it separated from the revolving shaft considering the vertical upper part as an outgoing radiation shaft of light. The light guide section 23 is installed in the part which counters the projector 2 of the partition plate 12. Moreover, opening 42b is prepared in the part which counters the projector 2 of a gobo 42, the exposure light by which outgoing radiation was carried out to the vertical upper part from the projector 2 passes through the inside of a light guide section 23, light-receiving field R2b, and opening 42b, and incidence is carried out to floodlighting field R2a by this. In addition, in order to prevent the scattered light from each part grade by the side of floodlighting field R2a etc. carrying out incidence to a light-receiving field R2b side through opening 42b, the scattered-light

restrictor ring 24 thicker than a gobo 42 is installed in opening 42b.
[0030] The exposure light by which outgoing radiation was carried out towards the vertical upper part from the projector 2 in the location from which it separated from the revolving shaft as described above It is reflected by the prism 21 and 22 which is the exposure photoconductive light means fixed to the inferior-surface-of-tongue side of the optical-system covering 14 which forms the upper limit of floodlighting field R2a, it is changed into the floodlighting incident light way La1 which goes to the vertical lower part which met the revolving shaft in the optical path, and incidence is carried out to floodlighting reflector 4a.
[0031] On the other hand, the electric eye 3 is installed on the revolving shaft, and incidence of the reflected light by which optical-path conversion was carried out is carried out to the light-receiving outgoing radiation optical path Lb1 by this through the light-receiving lens 31 at an electric eye 3 by light-receiving reflector 4b. In addition, it is good also about floodlighting of exposure light also as a configuration which installs a floodlighting lens, for example in a light guide section 23.
[0032] Drive control of these projectors 2 and electric eyes 3 is carried out by the floodlighting control circuit 20 and the light-receiving control circuit 30 in the floodlighting and light-receiving, respectively. The projector 2 and the electric eye 3 are further connected to the digital disposal circuit 5 (however, not shown [wiring of connection]). By this, the driving signal of a projector 2 and the light-receiving signal of an electric eye 3 are inputted into a digital disposal circuit 5, from the existence of light-receiving, the distance from the time difference of floodlighting and light-receiving etc. to a body calculates in a digital disposal circuit 5, and the existence of the body in the detection direction is called for again.
[0033] In conventional omnidirection distance detection equipment, to the optical-path conversion means, a projector and an electric eye counter and are arranged by each on the revolving shaft at the floodlighting field and light-receiving field side, respectively. In this case, there was a problem of being easy to be influenced with long wiring of the electrical noise from a rotation drive system etc. when it comes to [both] a limit when wiring of a signal line etc. becomes long since [of a revolving shaft] it is mostly installed in both ends, therefore the both ends of equipment, and a projector and an electric eye perform a rotation drive.
[0034] On the other hand, it sets to the equipment by this invention. Apart from the optical-system field R2 which consists of floodlighting field R2a and light-receiving field R2b The drive-system field R1 is established in either a floodlighting field R2a side or a light-receiving field R2b side (setting in the operation gestalt shown in drawing 1 light-receiving field R2b side), and both the projector 2, the electric eye 3, and the digital disposal circuit 5 into which the signal from them is inputted are installed in this drive-system field R1. When shortening wiring of these mutuals, and securing the degree of freedom of an equipment design and making it wiring not exist in the optical-system field R2 by this, the omnidirection distance detection covering 360 perfect degrees is attained. Furthermore, the omnidirection distance detection equipment whose precision of distance detection controlled the effect of the electrical noise to a light-receiving signal etc., and improved is realizable by shortening wiring in this way. Moreover, the miniaturization of equipment is also realizable by arranging a projector 2 and an electric eye 3 to the same field in this way.
[0035] Furthermore, since the weight of the equipment part supported with the transparence cylinder 13 which is the side attachment wall of the optical-system field R2 is reduced when a projector 2, an electric eye 3, and the drive-system field R1 in which the rotation mechanical-component 43 grade is installed are located in an equipment lower part, as shown in this operation gestalt, sufficient reinforcement can be obtained when thickness of the transparence cylinder 13 is made thin. By this, reduction of the amount of transmitted lights and distortion of an image can be controlled at the time of the outgoing radiation by the floodlighting outgoing radiation optical path La2 of exposure light, and the incidence by the light-receiving incident light way Lb2 of the reflected light, and the distance detection with a more high precision is attained.
[0036] Moreover, in this equipment, the gobo 42 is being fixed to the transparence cylinder 13 which is the side attachment wall of housing 1. Since it becomes the structure of also rotating a protection-from-light means when a protection-from-light means to separate a floodlighting field and a light-receiving field is being fixed to the rotation section, the load of a rotation drive increases. On the other hand, the functionality of a rotation drive can be raised more by making a gobo 42 into the structure fixed to housing 1. The absolute location of such a gobo 42 becomes possible by placing in a fixed position a projector 2, an electric eye 3 and prism 21, and 22 grades. With these absolute locations, optical-axis adjustment in equipment etc. can be easy-ized to coincidence.
[0037] Moreover, when floodlighting field R2a and light-receiving field R2b adjoin only through a gobo 42, decline in the light-receiving effectiveness by separating from a light-receiving prospective angle also in

short-distance measurement is controlled.
[0038] Next, detection of an include angle with the include-angle detection means in this equipment and the body by it is explained. The encoder disk 51 is attached in the part located in the optical-system field R2 of rotation supporter 40a, it is fixed to the partition plate 12 and the photoelectrical unit 52 is installed in the position on the periphery so that a part of periphery of the encoder disk 51 may be put. The transparency mold optical encoder for include-angle detection is constituted by this encoder disk 51, the photoelectrical unit 52, and the encoder control circuit 53 that controls these.
[0039] The include-angle detection slit group which consists of two or more slits arranged at intervals of a predetermined include angle is formed at the encoder disk 51 on the predetermined circle in the field which passes the inside of the photoelectrical unit 52 centering on the revolving shaft of the rotation section 40 at the time of rotation. Moreover, the criteria include-angle detection slit is formed on a concentric circle which is in the field which passes the inside of the photoelectrical unit 52 similarly at the time of rotation, and is different from the above-mentioned include-angle detection slit group. This criteria include-angle detection slit is prepared in order to determine the angular position used as the radix point of the include-angle detection by the include-angle detection slit group, it consists of a single slit according to terms and conditions, such as rotational speed of the rotation section 40, or consists of two or more slits, such as four slits of two slits of spacing, or 90-degree spacing, 180 degrees.
[0040] To the photoelectrical unit 52, on both sides of the encoder disk 51, a light emitting device is arranged at one side, the photo detector is arranged on another side, a photo detector can detect the light from the light emitting device which penetrated each slit of an include-angle detection slit group, and a criteria include-angle detection slit by this, and include-angle information can be acquired to it. In addition, in order to perform include-angle detection by such light, the protection-from-light case 54 is installed so that the field containing the photoelectrical unit 52 may be surrounded.
[0041] The signal from this transparency mold optical encoder is inputted into a digital disposal circuit 5, and the operation of an include angle with a body is performed. Also in this case, the photoelectrical unit 52 grade is adjoined and installed in the drive-system field R1, therefore all wiring of that signal line etc. is performed in the drive-system field R1. By this, like the signal line about distance detection, the signal line about include-angle detection can be shortened, and degradation of the resolution under the effect of electrical noise can be reduced. In addition, although not illustrated, the wiring way for wiring the signal line from a transparency mold optical encoder is established in the predetermined part in the field covered in the protection-from-light case 54 of the partition plate 12.
[0042] When a transparency form optical encoder which was described above is used, the resolution of include-angle detection is determined by arrangement spacing of the slit of an include-angle detection slit group. Although it is necessary to make arrangement spacing of a slit small for performing include-angle detection by the high resolution more, by there being a limitation and having enlarged the path of the encoder disk 51, equipment itself will enlarge the densification of slit arrangement. Then, artificers adopted the include-angle detection approach which makes angular resolution high by using together the include-angle detection by the transparency mold optical encoder, and detection with an electric clock (for example, JP,5-60575,A).
[0043] Drawing 3 is a timing chart for explaining the above-mentioned include-angle detection approach, and has shown the optical signal corresponding to an include-angle detection slit group, and the electrical signal by the predetermined frequency used together by include-angle detection. In this operation gestalt, the digital disposal circuit 5 is constituted including the clock circuit which generates the electrical signal of the shape of a high-speed pulse which has a predetermined frequency, and the include-angle arithmetic circuit which uses this electrical signal together and calculates an include angle. The frequency of the electrical signal generated by the clock circuit is set up so that the signal pulse separation may become small to the signal pulse separation of the optical signal decided by rotational speed of slit arrangement spacing of an include-angle detection slit group, and the rotation section 40. Moreover, the signal pulse Sn in an optical signal shows the signal pulse by the n-th slit from the criteria include angle detected by the criteria include-angle detection slit, sets slit arrangement spacing of an include-angle detection slit group to theta 0, and is equivalent to the include angle ntheta0, for example.
[0044] If the case where the rotation section 40 is rotating with constant speed is considered here, the number of the electrical signal pulse between two signal pulses S corresponding to the adjoining slit is fixed. This number is called for by zero N and measurement for example, between signal pulse Sn-Sn +1. At this time, include-angle spacing per electrical signal pulse is theta0/N0, and measurement of it by the high resolution which made angular resolution these include-angle spacing theta0/N0 by this is attained. That is, it supposes that the reflected light from a body was received in Timing T as an example, and supposing the

number of the electrical signal pulse from signal pulse Sn+1 at that time is one N, the include angle of the detected body will be called for with theta (n+1+N1/N0) 0.
[0045] By using the include-angle detection approach which used such an electrical signal pulse together especially, as described above, measurement by angular resolution higher than slit arrangement spacing is attained. Moreover, it becomes possible by changing the frequency of an electrical signal pulse to change the resolution of the include-angle detection, without changing slit arrangement spacing.
[0046] The omnidirection distance detection equipment by this invention is not restricted to the above-mentioned operation gestalt, and can deform variously.
[0047] Drawing 4 is the sectional view showing the configuration of the 2nd operation gestalt of the omnidirection distance detection equipment concerning this invention. In this operation gestalt, the transparence cylinder which is the side attachment wall of the optical-system field R2 is constituted by transparence cylinder 13b which is the side attachment wall of two transparence cylinders, i.e., transparence cylinder which is side attachment wall of floodlighting field R2a 13a, and light-receiving field R2b, and a gobo 42 is inserted into these transparence cylinders 13a and 13b, and is installed. Also by such configuration, the same effectiveness as the 1st operation gestalt can be acquired. In addition, in this operation gestalt, it is formed more thickly than what the thickness of a gobo 42 depends on the 1st operation gestalt, therefore the scattered-light restrictor ring is not installed in opening 42b.
[0048] Drawing 5 is the sectional view showing the configuration of the 3rd operation gestalt of the omnidirection distance detection equipment concerning this invention. In this operation gestalt, to the vertical axis, predetermined degree[of angle]-leans a projector 2 and a light guide section 23, they are installed, and the light guide of exposure light is performed by making into an exposure photoconductive light means the single prism 21 fixed to the optical-system covering 14 by this. In this case, optical-axis adjustment is simplified by that prism 21 is single.
[0049] above-mentioned the 1- although the whole of the 3rd operation gestalt arranges the electric eye on the revolving shaft of a rolling mechanism, it is also possible to divide an optical-system field so that a floodlighting field may adjoin a drive-system field conversely, and to consider a projector as the configuration arranged so that a floodlighting optical-path conversion means may be countered on a revolving shaft. At this time, an electric eye is arranged in the location from which it separated from the revolving shaft, and floodlighting and light-receiving are performed by having the reflected light light guide means which consists of a single or two or more reflecting prisms etc. which carry out the light guide of the reflected light towards an electric eye from a light-receiving optical-path conversion means. In this case, since the diameter of a spot is large compared with exposure light, the optical-axis adjustment in a light guide means is comparatively easy for the reflected light. Moreover, about opening on the gobo which passes the reflected light, compared with the case of exposure light, it is necessary to enlarge in order to fully take in the reflected light.
[0050]
[Effect of the Invention] The omnidirection distance detection equipment by this invention acquires the following effectiveness, as explained to the detail above. That is, by considering as the configuration which prepared the drive-system field which is a field where both a projector, an electric eye, and a digital disposal circuit are installed in the one side of the optical-system field which consists of a floodlighting field and a light-receiving field, as wiring of the signal line of these mutuals etc. does not pass through the inside of an optical-system field, it can consider as the omnidirection distance detection equipment in which 360 perfect omnidirection distance detection is possible.
[0051] Moreover, since the distance of wiring is shortened by this, the effect of the electrical noise to the light-receiving signal resulting from the drive system of a rolling mechanism etc. is controlled, and the precision of distance detection can be raised.

2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

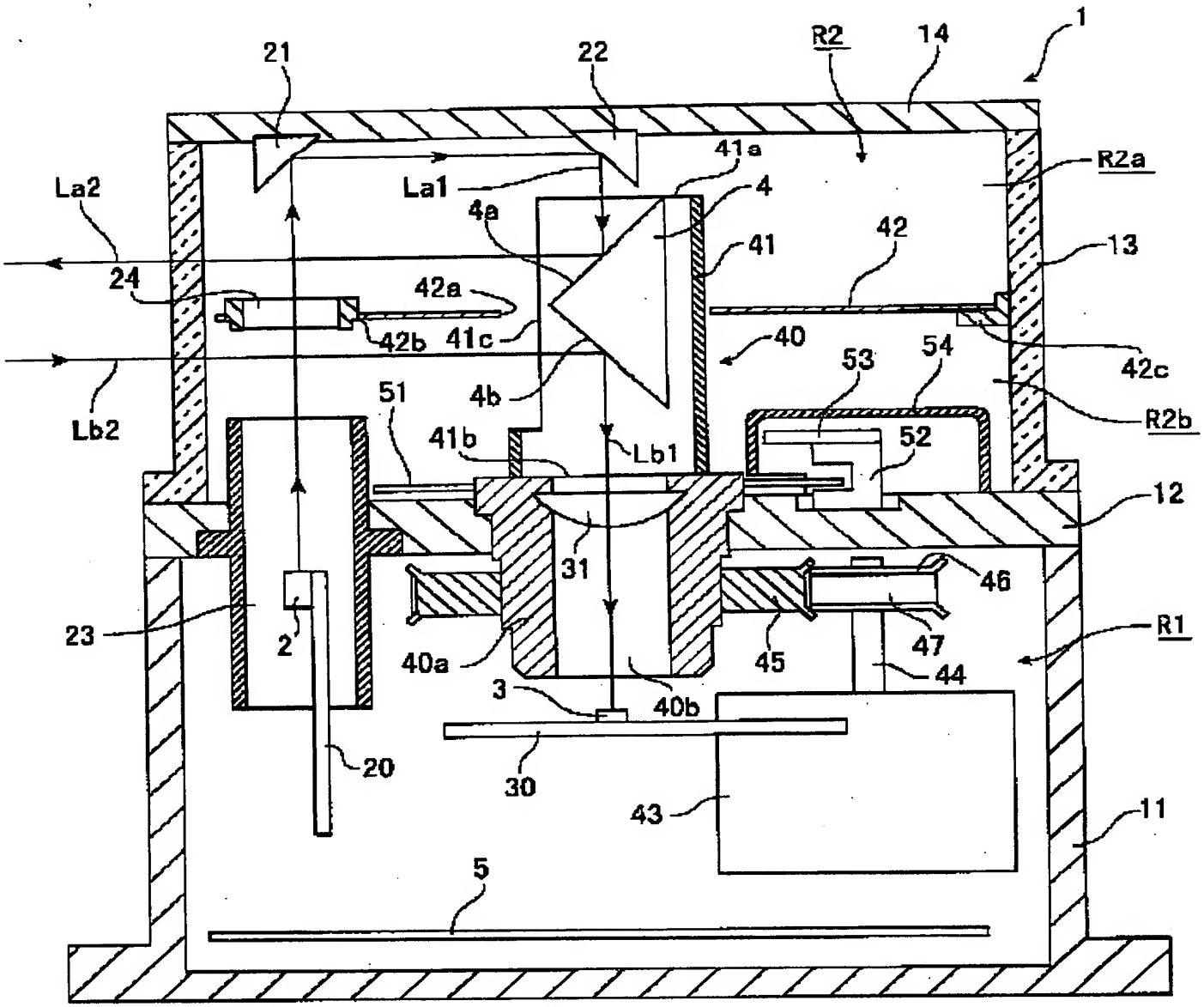
DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing the configuration of the 1st operation gestalt of the omnidirection distance detection equipment concerning this invention.
[Drawing 2] It is the perspective view showing roughly the optical system of the omnidirection distance detection equipment shown in drawing 1 .
[Drawing 3] It is a timing chart explaining the detection approach of an include angle with the body by the omnidirection distance detection equipment shown in drawing 1 .
[Drawing 4] It is the sectional view showing the configuration of the 2nd operation gestalt of the omnidirection distance detection equipment concerning this invention.
[Drawing 5] It is the sectional view showing the configuration of the 3rd operation gestalt of the omnidirection distance detection equipment concerning this invention.
[Description of Notations]
1 -- Housing, 11 -- Drive-system covering, 12 -- 13 A partition plate, 13a, 13b [-- Floodlighting control circuit,] -- A transparence cylinder, 14 -- Optical-system covering, 2 -- A projector, 20 21 22 [-- Electric eye,] -- Prism, 23 -- A light guide section, 24 -- A scattered-light restrictor ring, 3 30 [-- Floodlighting reflector,] -- A light-receiving control circuit, 31 -- A light-receiving lens, 4 -- Optical-path conversion prism, 4a 4b [-- Light guide line,] -- A light-receiving reflector, 40 -- The rotation section, 40a -- A rotation supporter, 40b 41 [-- Side-face opening,] -- A rotation cylinder, 41a -- Upper limit opening, 41b -- Lower limit opening, 41c 42 [-- Gobo fixed part,] -- A gobo, 42a -- Central opening, 42b -- Opening, 42c 43 [-- Rotation belt,] -- A rotation mechanical component, 44 -- 45 A rotation driving shaft, 46 -- A rotation ring, 47 5 [-- Encoder control circuit,] -- A digital disposal circuit, 51 -- An encoder disk, 52 -- A photoelectrical unit, 53 54 [-- A floodlighting field, R2b / -- Light-receiving field / La / -- A light-receiving outgoing radiation optical path, Lb2 / -- Light-receiving incident light way. /1 -- A floodlighting incident light way La2 -- A floodlighting outgoing radiation optical path Lb1] -- A protection-from-light case, R1 -- A drive-system field, R2 -- An optical-system field, R2a

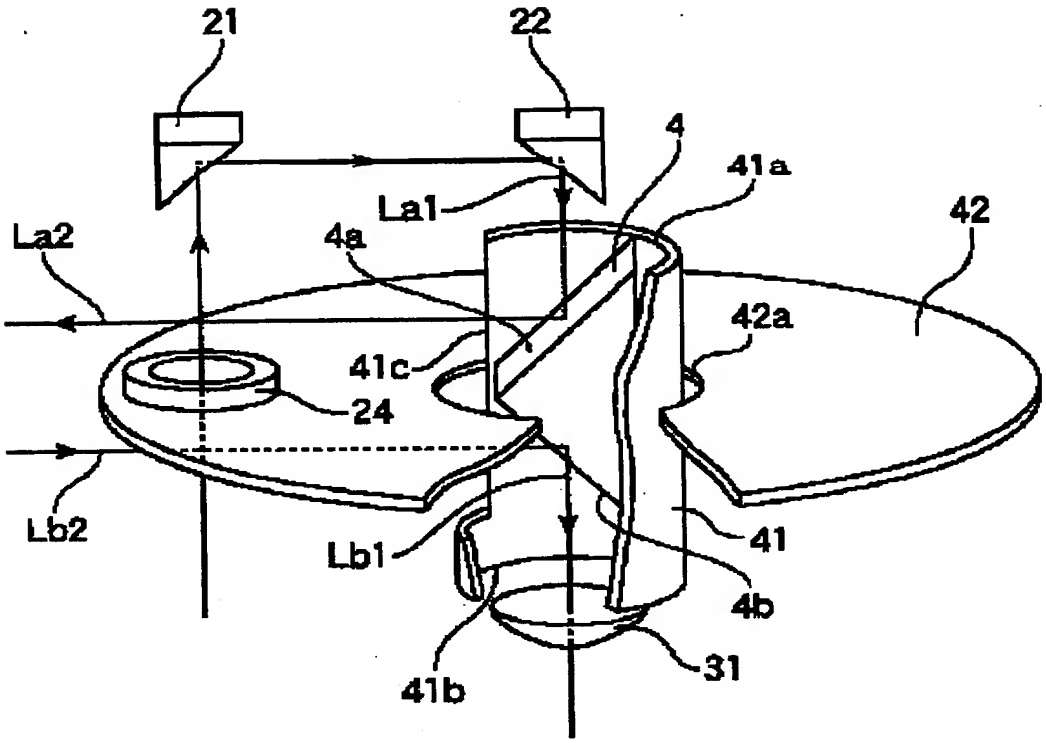
[Translation done.]

DRAWINGS

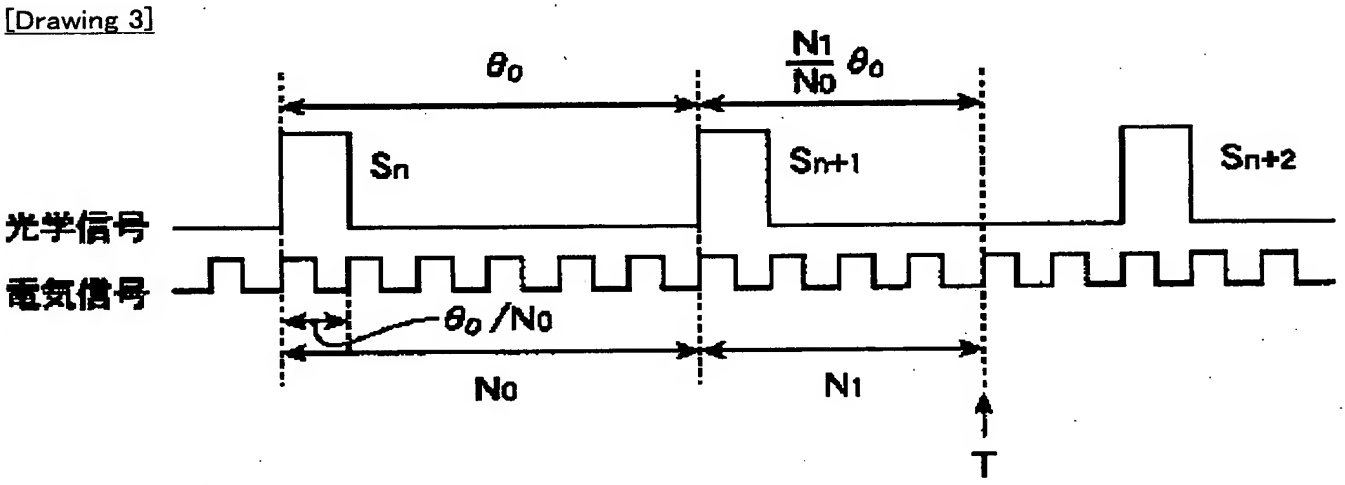
[Drawing 1]


1
21
22
R2
14
41a
R2a
La2
La1
4
4a
42
41
13
24
42a
42b
41c
40
53
54
42c
Lb2
51
4b
R2b
41b
Lb1
52
12
31
46
23
2
40a
45
47
R1
44
3
40b
20
30
43
11
5

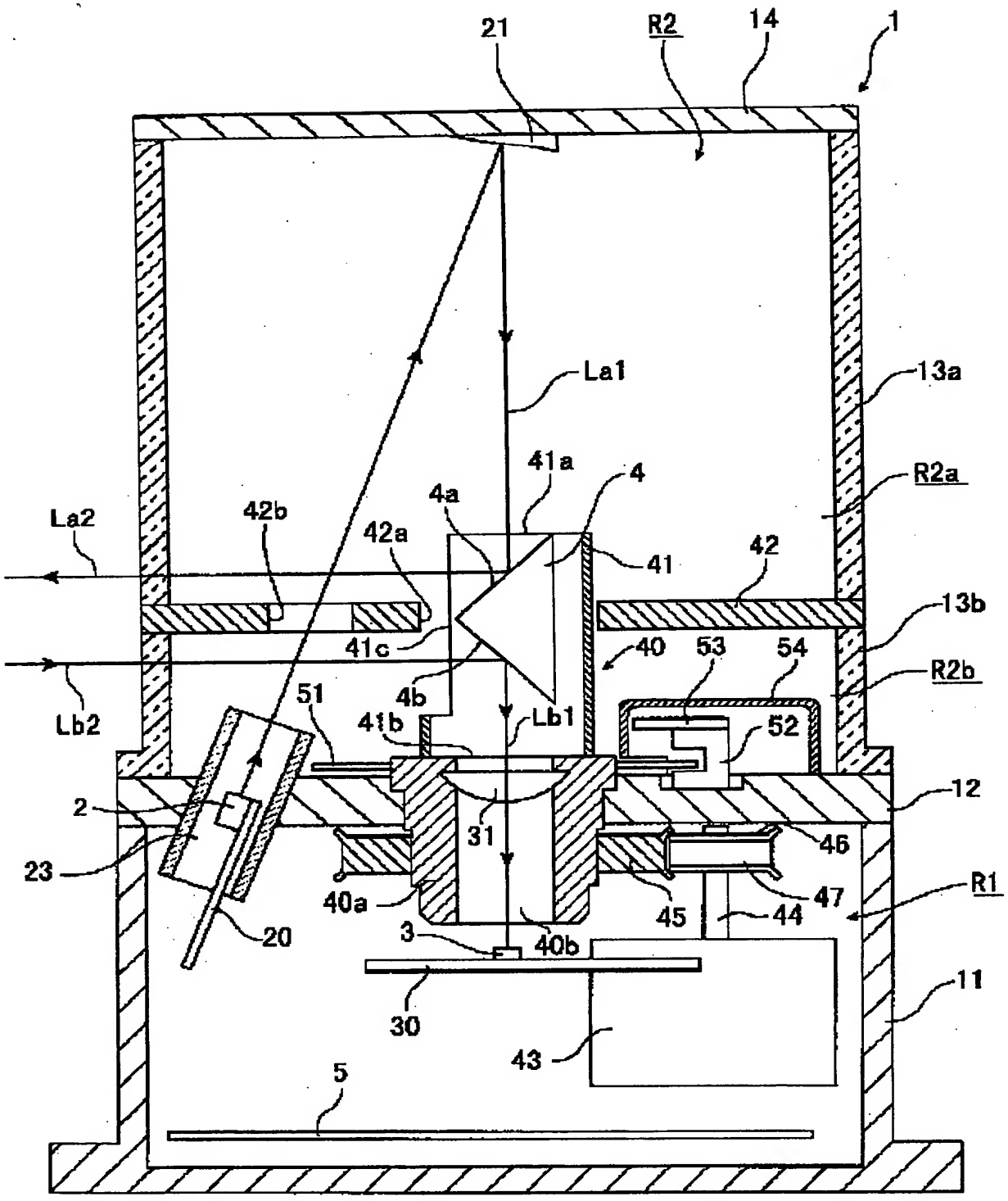
[Drawing 2]



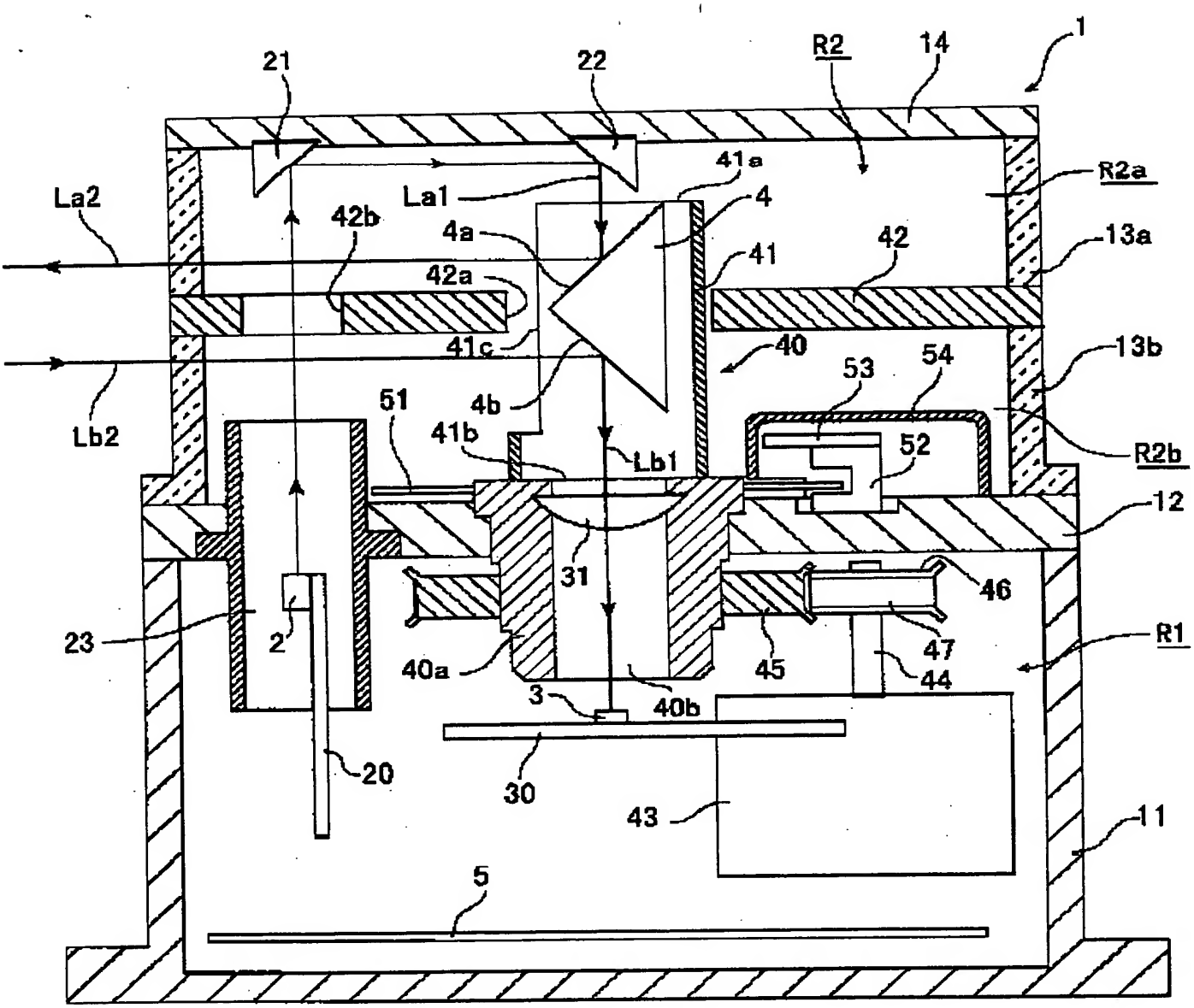
[Drawing 3]



[Drawing 5]


21
R2
14
1
La1
13a
41a
4
R2a
4a
La2
42b
42a
41
42
13b
41c
40
53
54
R2b
51
4b
Lb2
41b
Lb1
52
12
2
31
46
23
40a
45
47
R1
20
3
40b
44
11
30
43
5

[Drawing 4]



[Translation done.]